

CONTRIBUTIONS FROM THE LABORATORY OF THE UNIVERSITY OF  
PENNSYLVANIA.

## No. XX.

## CONTRIBUTIONS TO MINERALOGY.

By F. A. GENTH.

*(Read before the American Philosophical Society, August 18, 1882.)*

I. In a paper, read before the American Philosophical Society on September 19th, 1873, I communicated some observations on the occurrence of *Corundum*, and, especially, on its alteration into other minerals. Since then I had an opportunity to examine many beautiful specimens of the same kind, by which my views on the subject received the fullest confirmation. I was in hopes that I would be able to prepare a second edition of my paper, illustrated with carefully drawn figures of the most important and striking forms, but, finding that my time is too much taken up by other duties, I fear that I shall never accomplish my desire, and, for this reason, will place on record, as an appendix to my first paper, the description of a few very remarkable occurrences.\*

\* In his *Handbuch der Mineralchemie*, 2 Auflage, Leipzig, 1875, Prof. C. F. Rammelsberg repeatedly refers to the above investigation, but, unfortunately, gives me credit for statements which I never have made. As they are of too much importance to remain uncontradicted, I will briefly allude to the most striking.

On page 147 (*Spezieller Theil*), he says that I came to the conclusion that "*at the time, when chrysolite changed into serpentine, corundum was formed, which, subsequently, was altered into other minerals,*" while I simply state the fact that the largest deposits of corundum occur in serpentine, or in chrysolite, or the rocks immediately adjoining the same, and I do not even intimate that they were formed at the time when the latter changed into the former, as they occur equally in both; that I do not suppose (as Prof. R. seems to believe) that the alumina was eliminated from rocks which do not contain any appreciable quantity of it, is, I should think, sufficiently indicated by my query, "*by what agencies such enormous quantities of alumina could have been precipitated to form corundum?*"

On page 137, in quoting some of my analyses of the black spinels (ceylanites), Prof. Rammelsberg remarks that *their purity was very doubtful*, and that *besides the 4.31 per cent. of corundum, which were eliminated during the process of analysis, it must contain 9.6 per cent. additional*. If Prof. Rammelsberg had read my paper with the least attention, he would have found that I come pretty nearly to the same conclusion, for I say: "*that the most carefully selected material still contained a mechanical admixture of 13.36 per cent. of corundum.*" How little Prof. Rammelsberg seems to appreciate the drift of the whole investigation, is proved by the fact that he attacks the purity of my mineral species, when I never intended to publish these analyses as those of typical specimens of spinel, but, on the contrary, as *mixtures*, still showing remnants of the original species, and I distinctly say: "*This analysis, however, establishes the very important fact of the mechanical admixture of corundum.*"

On page 182, Prof. Rammelsberg says: "*According to Hunt bauxite is changed into corundum by strong ignition, and GENTH THINKS THAT THIS ALTERATION TAKES PLACE AT ORDINARY TEMPERATURE ALSO.*" Now, the second part of the sentence

1. *Corundum, altered into Spinel.*

a. At the Carter Mine, in Madison county, N. C., corundum is found in white and pink crystals, but mostly in irregular grayish-white or white cleavage masses, generally enveloping a variety of a delicate pink color. Where small cracks or fissures occur in the corundum, it can be observed, sometimes only by a small dark line, that a change has commenced which in many places extends through large masses, converting the corundum into a massive greenish-black spinel, with uneven fracture, and of a fine granular structure, rarely showing planes of octahedral crystals in the compact mass. It yields a grayish-green powder and has a specific gravity of 3.751. The spinel shows in many cases small scales of prochlorite, into which it finally passes.

With difficulty I have selected some which was free from prochlorite, but although the material appeared to be quite pure, it was found to contain a small quantity of unaltered corundum = 1.15%. The following are the results of my analysis (a), and after deducting silicic acid and corundum (b), calculated composition (c).

	a.		b.		c.	
Al <sub>2</sub> O <sub>3</sub>	= 66.02	—	66.74	—	FeFe <sub>2</sub> O <sub>4</sub>	= 1.94
Fe <sub>2</sub> O <sub>3</sub>	= 1.33	—	1.34		FeAl <sub>2</sub> O <sub>4</sub>	= 27.53
CuO	= 0.09	—	0.09		CuAl <sub>2</sub> O <sub>4</sub>	= 0.21
NiO	= 0.33	—	0.33		ZnAl <sub>2</sub> O <sub>4</sub>	= 0.50
ZnO	= 0.22	—	0.22		NiAl <sub>2</sub> O <sub>4</sub>	= 0.78
FeO	= 11.81	—	11.94		MgAl <sub>2</sub> O <sub>4</sub>	= 69.04
MgO	= 19.13	—	19.34			
SiO <sub>2</sub>	= 0.24	—	—			
Corundum	= 1.15	—	—			
	<hr/>		<hr/>			<hr/>
	100.32		100.00			100.00

b. At the meeting of the American Philosophical Society of March 17, 1882, Dr. Edgar F. Smith and Mr. N. Wiley Thomas described corundum from a locality, three-quarters of a mile north of Shimersville, in Lehigh county, where numerous crystals had been ploughed up. I am indebted to Dr. Smith for a variety of specimens. The crystals are mostly rough, and show the hexagonal prism and pyramid and basal planes. Many of them have some feldspar and mica attached, showing that they probably come from a granitic gangue. The color of the crystals is generally gray, a few, however, show a reddish or a pink color. Disseminated through all the crystals and frequently accumulating on the surface, are minute, very brilliant crystals of a highly titaniferous menaccanite; these are *not*

which he saddles on me, is Dr. Hunt's. I positively deny the possibility of such a change in the following language: "I do not know of a single instance in which corundum could have eliminated under such circumstances from the hydrate; on the contrary, the presence of grains of corundum in the bauxite proves pretty conclusively that the latter results from the hydration of corundum, and that the grains which have been found are remnants, not yet converted."

magnetic. It appears that this corundum has not been altered to a very great extent, only a few specimens of black spinel in irregular masses or rounded, pyramidal forms have been found, besides these only very thin yellowish or greenish, soft coatings, in very minute quantity, which may be a potassium mica. I could not get enough for examination. The spinel has an iron-black color, and is slightly magnetic. Its specific gravity is = 4.056.

Mr. George M. Lawrence has made an analysis of it in the Laboratory of the University of Pennsylvania, and found, after deducting 1.47% of silicic acid as follows (a); the calculated composition (b).

	a.		b.		
Al <sub>2</sub> O <sub>3</sub>	= 56.42	MgAl <sub>2</sub> O <sub>4</sub>	=	25.40	
Fe <sub>2</sub> O <sub>3</sub>	= 13.17	FeAl <sub>2</sub> O <sub>4</sub>	=	48.51	
FeO	= 22.95	FeFe <sub>2</sub> O <sub>4</sub>	=	26.09	
MgO	= 4.94			<hr style="width: 50%; margin: 0 auto;"/>	
TiO <sub>2</sub>	= 2.62			100.00	
	<hr style="width: 50%; margin: 0 auto;"/>				
	100.10				

The titanitic acid is present evidently as a mechanical admixture of menaccanite FeTiO<sub>3</sub>; deducting this and 24.16% of corundum, the composition of the pure spinel is given under (b). I do not consider the FeFe<sub>2</sub>O<sub>4</sub> a mechanical admixture of magnetite, as it cannot be dissolved out by hydrochloric acid.

### 2. Corundum, altered into Zoisite.

This is one of the rarer forms into which corundum is altered. I will add, therefore, Towns county, Georgia, as a new locality, where it occurs in small quantity.

The corundum is of a beautiful pink color, surrounded by greenish-white, cleavable zoisite.

### 3. Corundum, altered into Feldspar and Mica (Damourite).

When my first observations on the alterations of corundum were published, I expressed some doubt about the feldspar, as having been the results of such a change, because I had then not seen any specimens which gave positive evidence of it, although even at that time there was a great probability that a substance which, beyond any question, was found to be altered into fibrolite, cyanite, mica, zoisite, &c., could also, without difficulty, be converted into feldspars. Since then I have seen many specimens which remove my last doubts and prove that most of the occurrences, referred to in my paper, are the results of alteration. In addition to those already mentioned, I will give a few data which may be of interest:

a. I had mentioned a granular, yellowish or brownish-white oligoclase from Unionville, as the probable result of such a change. At the same

locality we find occurring in small quantities, remnants of crystals of gray corundum, generally surrounded by a little silvery mica in fine scales, in brownish-white or light brown cleavable feldspar, in masses sometimes from 25 to 30<sup>mm</sup> in diameter. The feldspar shows distinct triclinic striation. The corundum, where it is in contact with the feldspar or the micaceous coating, has a corroded appearance. The analysis gave :

SiO <sub>2</sub>	=	62.62	contains oxygen	33.36	
Al <sub>2</sub> O <sub>3</sub>	=	22.59	"	10.55	} = 3.6
Fe <sub>2</sub> O <sub>3</sub>	=	0.22	"	0.06	
MnO	=	trace			
MgO	=	0.18	"	0.07	} = 2.89
CaO	=	1.94	"	0.56	
Na <sub>2</sub> O	=	7.41	"	1.91	
K <sub>2</sub> O	=	2.52	"	0.35	
Ignition	=	2.45			
		<hr/>		99.93	

This feldspar, after its fine powder had been dried over sulphuric acid for several days, gave on ignition 2.45 % of water and, in another sample, 2.55 %. As there is not a sufficient amount of bases R<sub>2</sub>O and RO present for oligoclase, may not a portion of this water be basic water?

b. Another interesting occurrence of the alteration of corundum into a feldspar, is that at the "Black Horse" tavern, near Media, in Delaware county. The corundum, of a dark gray color in rough crystals, generally coated with a film of fine scaly mica, is imbedded in a finely granular brownish-white feldspar, which has probably resulted from its alteration. It has a specific gravity of 2.611, and the mean of two closely agreeing analyses, is as follows :

SiO <sub>2</sub>	=	58.42	contains oxygen	31.16	
Al <sub>2</sub> O <sub>3</sub>	=	23.14	"	10.82	} = 10.87
Fe <sub>2</sub> O <sub>3</sub>	=	0.18	"	0.05	
MnO	=	trace			
MgO	=	0.35	"	0.14	} = 3.45
CaO	=	3.13	"	0.89	
SrO	=	trace			
BaO	=	2.56	"	0.27	
Na <sub>2</sub> O	=	3.68	"	0.95	
K <sub>2</sub> O	=	7.06	"	1.20	
Ignition	=	1.54			
		<hr/>		100.06	

The constituents of R<sub>2</sub>O(RO) : R<sub>2</sub>O<sub>3</sub> : SiO<sub>2</sub> are in the ratio of 3.45 : 10.87 : 31.16, which is = 1 : 3.1 : 9, or almost exactly that of oligoclase.

It is an interesting fact that a part of the calcium oxide is replaced by barium oxide.

c. The Presley Mine in Haywood county, N. C., has furnished some very remarkable specimens of corundum, altered into feldspar as well as mica (muscovite).

α. The corundum at that Mine is generally of a grayish-blue color, sometimes in large crystals, more or less altered into the two minerals mentioned. Frequently in the interior of the crystals, when the altering agents had access by fissures or otherwise, small patches of white, cleavable feldspar may be seen, often, but not always, surrounded by mica. In other specimens, very little of the original mineral is left, and the grayish blue, deeply striated nucleus of corundum is surrounded by an aureole of exceedingly delicate, subfibrous mica (damourite) variable in thickness from 1 to over 20<sup>mm</sup> in diameter. When in immediate contact with the corundum the altered mineral is generally almost compact and scarcely presents a crystalline structure, farther away from it, it becomes more scaly, the scales increasing in quantity and size; often large plates are mixed with very fine scales of mica. The color of the compact and subfibrous mica is generally of a very delicate pink, but sometimes also white with silky lustre; the scales are mostly white with a yellowish or silver-gray tint. Masses of such, partly altered corundum, of over 150<sup>mm</sup> in diameter have been found, containing nuclei of nearly unaltered corundum of from 10 to 100<sup>mm</sup> in diameter, sometimes showing the beginning of a change into mica and albite, where the alteration has been facilitated by fissures.

β. A very remarkable specimen from the same mine is an imperfect crystal of muscovite with plates of 35<sup>mm</sup> in diameter, showing three or four sides of a six-sided prism. The upper and lower part of the original crystal are broken off, but it is still over 50<sup>mm</sup> in height. It has an eminently basal cleavage, easily splits into thin elastic laminae and has a brownish-gray color. In the center of the crystal and also in the lower part are remnants of smooth, bluish-gray cleavable corundum from 8 to 10<sup>mm</sup> in diameter. On the exterior portion of the muscovite are small quantities of albite.

γ. The alteration of corundum into muscovite and albite is perhaps still better represented by a specimen, consisting of an imperfect crystal of muscovite of a brownish-gray color, of over 80<sup>mm</sup> in diameter and a thickness of 40<sup>mm</sup>, to which is attached, especially on one side, white, cleavable albite. The whole specimen is over 150<sup>mm</sup> long, about 85<sup>mm</sup> broad and 45<sup>mm</sup> thick. Disseminated through the mass, both the mica and the feldspar, are remnants of crystals of grayish-blue corundum. Generally there is a thin seam of mica between the corundum and feldspar, but, in many places, the latter is in immediate contact with the corundum. The corundum shows distinctly the action of dissolving agents, it is rounded, smooth, as, if waterworn, sometimes corrugated, etc.

The whole mass has the appearance of a coarse granite, in which the quartz is replaced by corundum.

The corundum closely resembles the coarse crystals which are associated with mica and feldspar at Ilmensk and the River Barsovka in the Ural.

The analysis of the broadly foliated muscovite (c 1), that of the albite (c 2).

d. Very interesting varieties of altered corundum have been discovered by Mr. J. A. D. Stephenson of Statesville, N. C., at Belt's Bridge, Iredell county, N. C. The corundum has a gray and grayish-white color, and occurs in masses, sometimes over a foot in diameter, but generally smaller; they are irregular in form, always more or less rounded, sometimes globular, egg-shaped, rarely pyramidal and showing yet the crystalline form of corundum, but of the original mineral, many of the globular masses do not contain a trace, others contain small particles, disseminated through the mass, or a nucleus in the center. The altered mineral is mostly mica (damourite) some of the specimens also contain black tourmaline in radiating crystalline masses, which sometimes start from the corundum nucleus, but not always. The mica is either compact, of a grayish-white color or subfibrous (analysis (d1) by Miss Mary T. Lewis, after deducting 3.51 of corundum), and very fine scaly with pearly lustre, the scales rarely assume a size of more than 2<sup>mm</sup> in diameter. In one of the specimens in which all the corundum has disappeared, I noticed minute cavities, containing fragments of a vitreous mineral which appears to be quartz, but the quantity was too small for further examination.

In connection with this, I will mention a specimen from the same locality, received by Col. Joseph Willcox. It appears to be a fragment of an irregular hexagonal prism, a little over 100<sup>mm</sup> high, and somewhat less broad. The original form is scarcely perceptible, the sides being rounded and rough. There is a core of unaltered gray corundum of 65 × 55<sup>mm</sup> surrounded with subfibrous, and on the outside with scaly mica, inclosing bunches of radiating, black tourmaline; disseminated through the unaltered corundum are many rounded masses of a brownish-red garnet from 4 to 6<sup>mm</sup> in diameter, an association which I never before have observed. The analysis of the subfibrous mica, surrounding this corundum, which has been made by Mr. Frank Prince shows that a portion of the alkalis has been replaced by lime (d2).

e. In 1876 corundum was discovered in the micaceous schists near Bradford, Coosa county, Alabama, of which numerous specimens have been kindly presented to me by Dr. Eugene A. Smith, State Geologist of Alabama.

It is usually found in hexagonal prisms, but also in pyramidal form, apparently 2, always, however, very rough and altered.

The corundum itself is of a brown and bronze color; sometimes exhibiting a star of six rays. Amongst the large number of specimens which I have examined, I have never seen one which was free from an admix-

ture of grains of menaccanite ; in some of the crystals there were only a few small ones, rarely over one millimetre in size, in others, the quantity, disseminated through the corundum, is very large, and a great portion, probably in the act of crystallization, has been pushed to the outside of the corundum crystals, and gives them a coating of menaccanite, which sometimes reaches a thickness of 5<sup>mm</sup>. The menaccanite grains have no distinct form, they have an iron-black color, and, on a fracture, submetallic lustre, they are not magnetic, and gave the following composition :

TiO <sub>2</sub>	=	17.62
Fe <sub>2</sub> O <sub>3</sub>	=	67.36
Al <sub>2</sub> O <sub>3</sub>	=	3.73
FeO	=	11.14
MgO	=	0.27
SiO <sub>2</sub>	=	0.41
		100.53

The only alteration of this corundum which I have noticed, is that into mica and small quantities of tourmaline, but the specimens which have been obtained from this locality are the most beautiful and of great scientific interest.

The brown corundum is surrounded with greenish-white subfibrous mica, showing under a good magnifier a very fine scaly structure ; this mica is sometimes only a very thin coating, but frequently from 2 to 5<sup>mm</sup> in thickness, surrounded by fine scaly mica, much of which has changed to brown scales with submetallic lustre, which largely exfoliate when heated, like jefferisite or maconite. In some specimens the subfibrous mica peels off and then shows the edges of the corundum rounded, and the whole surfaces acted upon, as if by a solvent ; other specimens contain a core of brown corundum with the star of six rays ; the corundum still shows the rounded hexagonal form, but the subfibrous greenish-white mica forms a ring around it with *perfect hexagonal sides* and sharp edges (analysis e), the whole being imbedded in fine scaly mica schist. Where many of such partly altered corundum crystals are crowded together in the mica schist, the appearance reminds one of plum pudding.

Many of the corundum crystals are almost completely changed into mica. Then they are often flattened out, and form irregular nodules in the mica schist, having a whitish or greenish-white color, are fine scaly on the surface (sometimes imbedding small slender crystals of black tourmaline), but compact or very fine granular in the interior. On breaking, some show yet minute traces of unaltered corundum ; others have not a trace of it left, and have not the remotest resemblance to mica, but more the appearance of a grayish white compact limestone. Analysis of the compact mica (e2).

The menaccanite which was in the original mineral is also present in the altered.



The analyses gave :

	e 1	e 2	d 1	d 2	e 1	e 2
Spec. Grav.	= 2.640	—	—	—	—	—
SiO <sub>2</sub>	= 65.52	— 45.26	— 45.96	— 44.03	— 44.54	— 45.00
Al <sub>2</sub> O <sub>3</sub>	= 22.25	— 36.33	— 38.22	— 40.16	— 36.52	— 36.08
Fe <sub>2</sub> O <sub>3</sub>	= trace	— 1.96	— 0.61	— trace	— 3.26	— 2.73
MgO	= —	— 0.14	— —	— —	— 0.37	— 0.72
CaO	= 1.96	— 0.35	— 0.37	— 3.14	— 0.23	— 1.01
Li <sub>2</sub> O	= —	— —	— trace	— trace	— trace	— trace
Na <sub>2</sub> O	= 9.54	— 0.48	— 0.74	— 1.42	— 0.65	— 1.35
K <sub>2</sub> O	= 0.53	— 11.09	— 9.21	— 6.66	— 10.38	— 7.79
Ignition, †	= 0.22	— 4.50	— 4.89	— 5.04	— 4.65	— 4.68
	100.02	— 100.11	— 100.00	— 100.45	— 100.60	— 99.36

f. Another locality which furnishes flattened nodules of mica, with a nucleus of corundum, is the Haskett mine in Macon county, N. C. They are mostly small, rarely over 10<sup>mm</sup> in diameter, and contain a grayish-white corundum, surrounded by a subfibrous or fine sealy mica.

There are many other localities in which corundum altered into mica have been observed since the publication of my paper, but the specimens from them do not present any other than ordinary interest, I will therefore mention only a few localities: Franklin, Sussex county, N. J. (rare), Hogback, Jackson county, N. C., Cheochee, S. C., and also corundum from gravel beds, at the Placer mines at Gainesville, Ga., Brindetown and elsewhere in Burke county, McDowell county, etc., N. C.

#### 4. *Corundum, altered into Margarite.*

The change of corundum into potassium mica is far more common than that into calcium mica or margarite.

a. One of the first observed in this State was brought to our notice by Prof. B. Silliman, in 1849, who published a description of that, found near Village Green (Am. Journ. of Sc. [2] viii, 378), of which he gives several analyses by Mr. W. J. Craw. When I published my paper on corundum, I did not notice this occurrence, as I had, at that time, not been able to examine any specimens. The corundum is of a dark brown color, showing sometimes, especially when wet, beautiful reflections of a rich bronze color and submetallic lustre. It is mostly in remnants of imperfect crystals imbedded in the altered mineral in scales of a silver white color and pearly lustre. I have also some specimens which are imperfect crystals having a core of unaltered corundum, surrounded with subfibrous and fine sealy margarite.

I will mention that the locality formerly known as Village Green is *now* Samuel Smith's farm (formerly Isaac Morgan's), Aston township, Delaware county, Pa.



h. At the Hogback Mine, Jackson county, N. C., most of the corundum which is altered changes into muscovite, but margarite also occurs. It is found with corundum, associated with an earthy yellowish mineral, like that of Gainesville, Ga., mentioned in my first paper, in which it is imbedded in small white pearly scales, often fan-shaped and radiating from a center. I had only a small quantity of not quite pure material, of which I have made a partial analysis (b).

c. I have analyzed a specimen from Unionville, Pa., which is quite interesting:—

The mass consists of a greenish-white, compact mineral, showing only very slightly a fine granular structure. Interlaminated are very thin micaceous strata, separating the compact mineral into layers; the whole inclosing a nucleus of unaltered gray corundum. The outside of the mass is coated with a scaly mica, the individual scales varying from 1 to 2<sup>mm</sup> in size, which is evidently the result of an alteration, showing in the first place the change of corundum into compact margarite, and secondly, the change of the latter into muscovite.

The analysis of the margarite, as pure as can be selected, is given below (c 1), but also a partial analysis of the resulting muscovite, but of material, containing an admixture of margarite (c 2).

d. Very remarkable specimens of corundum, usually surrounded by margarite have been found at Hendrick's farm, Iredell county, N. C. The corundum occurs in hexagonal crystals, sometimes tapering, as if they were very acute hexagonal pyramids, with basal plane. They are very perfect and from 50 to 125<sup>mm</sup> in length, of a pale brownish or grayish-white color. Many of the specimens contain numerous cavities which in most cases are small and indistinct, so that it is difficult, if not impossible, to suggest, what may have produced them, others show a hexagonal form, but in one specimen, which contains larger cavities, some from 10 to 15<sup>mm</sup> in size, very little doubt is left that the mineral which previously occupied them was corundum in crystals showing a hexagonal pyramid and prism.

The corundum from Hendrick's farm is always altered on the surface, which is enveloped by a coating of margarite, from 1 to 6<sup>mm</sup> in thickness. It is rarely subfibrous and fine scaly, but mostly compact and more or less porous. It has some black tourmaline in small crystals or crystalline groups imbedded in it, and on its surface it is beginning to change into muscovite. Where the margarite is in contact with the corundum, the latter has become rough and eaten. The analysis of the purest from this locality gave me the results (d 1), a less pure specimen was analyzed in the Laboratory of the University of Pennsylvania by Mr. Frank Julian (d 2).

	b	c 1	c 2	d 1	d 2
Specific Gravity	—	2.997	—	3.004	—
SiO <sub>2</sub>	29.07	34.10	—	32.55	33.10
Al <sub>2</sub> O <sub>3</sub>	50.44	47.38	—	48.87	52.20
Fe <sub>2</sub> O <sub>3</sub>	trace	0.34	—	0.60	trace
MgO	—	0.17	—	0.23	—
CaO	11.63	9.20	—	10.48	8.44
Li <sub>2</sub> O	—	trace	—	trace	trace
Na <sub>2</sub> O	—	1.14	0.80	2.38	2.59
K <sub>2</sub> O	—	2.34	8.80	0.43	—
Ignition	6.63	4.43	4.15	4.34	4.85
Corundum	—	0.54	—	—	—
		99.64		99.88	101.18

### 5. Corundum, altered into Fibrolite.

a. In my previous paper I mention an observation by Prof. C. U. Shepard that at the Falls of the Yantic near Norwich, Conn., small crystals of sapphire are completely surrounded by fibrolite. Since then, Prof. George J. Brush has kindly presented to me a specimen which is quite interesting. It is a fibrolite of a brownish-white color, and shows, if examined with a strong lens, disseminated through the mass, numerous particles or remnants of grayish-blue corundum from which the fibrolite was formed; but besides, there is implanted in the fibrolite, a small hexagonal crystal of brown corundum 5<sup>mm</sup> long and 1.5<sup>mm</sup> thick, which must have crystallized at the time when the fibrolite was formed.

b. Recently this rare alteration of corundum into fibrolite has been found in numerous specimens at Shoup's Ford, Burke Co., N. C.

The corundum occurs in a mica schist in crystals, varying generally between 20 and 75<sup>mm</sup> in length and from 10 to 45<sup>mm</sup> in thickness, it has a brown or a bronze color and many crystals exhibit a star of six rays. The crystals are frequently flattened, always altered on the surface, rarely to a depth of 5<sup>mm</sup>. The alteration consists of an aureole of very fine fibrous and radiating white fibrolite.

It seems that subsequently the fibrolite underwent a partial alteration into mica, as the mica schist in which the crystals are imbedded contains still a large admixture of fibrolite.

c. I have very little doubt that the alteration, described by Sillem (Jahrb. für Mineralogie, 1851, 385), of corundum into quartz from Barsovka in the Ural is really that into fibrolite.

The altered mineral surrounds a core of unchanged corundum from which it radiates.

My opinion is supported by the fact that Sillem's description of this alteration is identical with mine of corundum into fibrolite; then, that quartz very rarely assumes a radiating structure; that fibrolite has nearly the hardness of quartz; and finally that his statement is not supported by an analysis.

6. *Corundum, altered into Cyanite.*

a. In the gravel, two miles West of Statesville, Iredell Co., N. C., an interesting specimen has been found, consisting of a nucleus of pink colored corundum, around which is crystallized pale blue cyanite which latter has evidently resulted from the alteration of corundum.

b. In some specimens which I have received since the publication of my first paper on corundum, I have observed that the coarsely-bladed crystalline masses of cyanite from Wilkes county, N. C., resulting from the alteration of corundum, are further changed into micaceous minerals. They are very finely granular, scaly, and show the bladed structure and cleavage of the original cyanite, and between the laminae minute scales of mica and a little quartz.

They have a grayish to brownish-white color, faint pearly lustre. H = 2.5. sp. gr. = 2.920. The purest material has been analyzed by my son, Mr. F. A. Genth, Jr., who found :

SiO <sub>2</sub>	=	35.58
Al <sub>2</sub> O <sub>3</sub>	=	49.42
Fe <sub>2</sub> O <sub>3</sub>	=	trace
MgO	=	trace
CaO	=	6.34
Na <sub>2</sub> O	=	2.11
K <sub>2</sub> O	=	3.01
H <sub>2</sub> O	=	4.12
		100.58

This analysis would correspond to about 59 % of calcium-sodium-mica (margarite), 29 % of potassium mica (muscovite), 9.7 % of unaltered cyanite and about 2.6 % of quartz.

7. *When were the Corundum Alterations formed?*

In many of the gravel beds in the Southern States, especially in North Carolina and Georgia, corundum is frequently met with, very rarely associated with diamonds, but generally with gold, zircon, monazite, xenotime, brookite, octahedrite, rutile, menaccanite, chromite, magnetite, cyanite, garnet, epidote, &c.

The corundum is sometimes, but rarely found in crystals of the usual form, mostly in fragments and cleavage pieces with very sharp edges and angles, which hardly ever are water-worn. These fragments show that the minerals have been broken by a very great force which had acted upon them very rapidly. Many of these fragments give evidence that, at the time when the corundum was broken up, a great portion of it had already undergone an alteration into other minerals. The most frequent are muscovite, mostly in fine scales, sometimes in subfibrous coatings; some also show feldspar, margarite, black spinel and tourmaline, and very rarely cyanite, usually containing a nucleus of corundum. The altered minerals, accord-

ing to their hardness are more or less water-worn and rounded, whilst the corundum which they enclose is quite sharp and angular, which fact proves that, *since the great gravel deposits were formed no alteration of the corundum has taken place in these deposits.*

### *II. Alteration of Orthoclase into Albite.*

Orthoclase changed into albite is undoubtedly one of the most interesting alteration of one mineral into another. Numerous occurrences of it have been observed in Europe, but I am not aware that it ever was noticed in this country; I will therefore give the description of an occurrence from the neighborhood of Philadelphia.

At the gneiss quarries of Upper Avondale, in Delaware county, Pa., druses have some time ago been found, which are lined with crystals of albite, associated with those of muscovite, and rarely with beautiful, but very minute, crystals of white beryl in hexagonal prisms and many pyramids, small crystals and groups of black tourmaline and calcite in cleavage masses and small scalenohedra, 1<sup>3</sup>, and thin hexagonal plates, which had so much the form of muscovite crystals that, at first, they were thought to be pseudomorphs. Mr. Lewis Palmer, of Media, presented me with a number of specimens.

The albite appears in short, stout colorless or white crystals, mostly in twins, showing principally the planes *I. O. i- $\bar{i}$ . 2- $\bar{i}$ . i- $\bar{3}$  and 1- $\bar{i}$ . and 1*; the latter plane very small and indistinct. Many of the crystals are very small and imperfect, and form a crystalline coating upon the cleavage masses, either directly upon a flesh-colored orthoclase or a grayish-white plagioclase intervening. I have analyzed perfectly colorless crystals (1).

Some of the specimens show conclusively that the albite is more recent than the orthoclase, and results from the decomposition of the latter, sometimes with the intermediate development of a plagioclase, and that the crystals and crystalline masses of muscovite have resulted at the same time, and contain the potassium oxide of the former orthoclase. The orthoclase which is associated with these albite crystals forms flesh-colored cleavage masses, which on the cleavage planes are bright and lustrous. The purest which with a strong lens appeared to be without admixture, was examined by my son, Mr. F. A. Genth, Jr. In their sections under the microscope it shows the rectangular reticulation characteristic of orthoclase, but disseminated through it, minute particles of plagioclase, giving proof of an incipient alteration (2).

One specimen, particularly is quite interesting. It is a mass of coarse cleavage particles of flesh-colored and white feldspars, with colorless albite crystals in cavities and crystals and scaly aggregations of muscovite and a little quartz. A cleavage crystal of flesh-colored orthoclase, especially on one side shows a rotten appearance, as if in part eaten away and one of the edges and planes is replaced by a lining of albite in the form of an imperfect crystal made up by an aggregation of many small

individuals, joined together. In other places the albite gradually pushes itself, as it were, into the orthoclase, leaving in many instances only a small nucleus of the flesh-colored feldspar in the white.

In other instances there is between the orthoclase and the crystals of albite a grayish or grayish-white cleavable feldspar with deep striation. The analysis (3) shows it to be a mixture of albite with oligoclase, the oxygen ratio between  $R_2O$  (RO) :  $Al_2O_3$  :  $SiO_2$  being = 1 : 3.1 : 10.6.

Although not in connection with the alteration of orthoclase into albite and muscovite, I will mention that at the same locality orthoclase has also been found in colorless crystals (4), and white cleavage masses (5) associated with imperfect crystal of muscovite.

The analyses gave the following results :

	1	2	3	4	5
	Crystals of albite	Orthoclase, flesh-red cleavage mass	Albite and oligoclase, cleavage mass.	Crystals of orthoclase, colorless.	Orthoclase, white cleavage mass.
Spec. Grav.	= 2.604	— 2.555	— 2.620	— 2.595	— 2.572
Si <sub>2</sub> O	= 68.52	— 64.53	— 65.22	— 65.84	— 65.03
P <sub>2</sub> O <sub>5</sub>	= —	—	—	—	— 0.08
Al <sub>2</sub> O <sub>3</sub>	= 19.44	— 19.64	— 21.44	— 19.50	— 19.22
Fe <sub>2</sub> O <sub>3</sub>	= —	— trace	— 0.20	—	—
MnO	= —	—	— trace	—	— trace
MgO	= —	— 0.25	—	—	—
CaO	= —	— 0.16	— 2.07	— trace	— 0.32
BaO	= —	—	—	— 0.08	—
Na <sub>2</sub> O	= 11.42	— 1.77	— 9.36	— 3.93	— 1.71
K <sub>2</sub> O	= 0.65	— 13.62	— 1.16	— 10.69	— 14.18
Ignition	= —	— 0.71	— 0.58	— 0.22	— 0.13
	— 100.03	— 100.68	— 100.03	— 100.26	— 100.67

Such alterations of orthoclase into albite occur not only in the quarries of Upper Avondale ; in the lower quarries at Leiperville similar facts can be observed, although not so striking, many of the large orthoclase crystals showing small patches of a thin coating of a white feldspar, albite or oligoclase, in many places penetrating into the orthoclase to a considerable extent.

Oligoclase is very common in our gneissic rocks, often associated with orthoclase, and very probably it is the result of the alteration of the latter.

### III. Alteration of Talc into Anthophyllite.

The suggestion which I made over 20 years ago (Am. Journ. Sc. [2] xxx, 200), that the chrome and nickel-bearing serpentines have resulted from the alteration of chrysolite, is, at present, I believe, generally admitted, since the numerous investigations of Tschermak, von Drasche,

Groth, Sandberger, and others, have established beyond doubt that this change from the one mineral into the other is almost universal.

At that time I have also shown that at Webster, Jackson county, N. C., a foliated talc has in a similar manner resulted from the alteration of chrysolite. The latter alteration has since been observed in most of the localities in the Southern States, where corundum deposits are found associated with chrysolite rocks.

In Pennsylvania, where the unaltered chrysolite rock has never been observed, a rock has been found which is its representative and contains the same constituents, only in different proportions. In North Carolina the granular chrysolite always contains small quantities of enstatite (bronzite), in Pennsylvania on the contrary we have an enstatite (bronzite) rock, containing small grains (from 5 to 10%) of chrysolite. It is best developed at Castle Rock, Delaware county, also near Wood's Chrome Mine in Lancaster county.

In all the chrysolite rocks small grains or crystals of chromite are disseminated through the mass of the rock; in the serpentine, which has resulted from the alteration of the chrysolite, these crystals or grains are still present and give evidence of the original mineral. This is also the case with a peculiar variety of talc, the so-called "indurated talc," which occurs a few hundred yards south-south-west from Castle Rock, Delaware county, Pa. It is compact, with a strong lens shows a cryptocrystalline, slightly scaly structure, and an impure grayish-olive green color. H = 2. Sp. Gr. = 2.789. Fracture splintery to subconchoidal; dull.

The analysis gave :

			Calculated :
SiO <sub>2</sub>	=	62.48	61.92
TiO <sub>2</sub>	=	trace	
Chromite	=	0.20	
Cr <sub>2</sub> O <sub>3</sub>	=	0.13	
Al <sub>2</sub> O <sub>3</sub>	=	0.59	
NiO	=	0.16	
FeO	=	4.95	5.57
MgO	=	27.60	27.86
Ignition	=	4.81	4.65
		<hr/>	<hr/>
		100.92	100.00

This is a talc, in which about one tenth of the magnesia is replaced by ferrous oxide = H<sub>2</sub>(Mg<sub>10</sub><sup>9</sup>Fe<sub>10</sub><sup>1</sup>)<sub>3</sub>Si<sub>1</sub>O<sub>12</sub>, represented by the calculated analysis above given.

Talc is generally one of the *final* products of the alteration of other rocks and minerals, but in this case, it has suffered a very remarkable change into anthophyllite. It is enveloped by an aureole of a white or grayish-white mineral, radiating from the nucleus of talc, having a thickness of from a few to over 15<sup>mm</sup>. The mineral is fibrous, of silky lustre

and shows a large cleavage angle, similar to amphibole; the terminal planes are either not developed or broken off. It incloses, like the original talc, grains of chromite. Its Spec. gravity was found to be 2.983. Besides my analysis (a) I will give, for comparison, the analysis by Dr. A. Brezina of the anthophyllite from Hermannschlag in Moravia (Tschermak's Mineral. Mitth., 1874, 247).

		Castle Rock.		Hermannschlag.
SiO <sub>2</sub>	=	56.88	—	57.39
Al <sub>2</sub> O <sub>3</sub>	=	2.45	—	2.04
Cr <sub>2</sub> O <sub>3</sub>	=	trace	—	—
Fe <sub>2</sub> O <sub>3</sub>	=	—	—	0.42
FeO	=	9.20	—	6.53
MnO	=	0.28	—	—
NiO	=	0.17	—	—
MgO	=	28.50	—	29.08
CaO	=	—	—	0.69
Na <sub>2</sub> O	=	0.18	—	—
K <sub>2</sub> O	=	0.03	—	—
Ignition	=	2.28	—	2.56
		<hr/>		<hr/>
		99.97		98.71

From the description of the mica globules from Hermannschlag, by Director G. Tschermak (Tschermak's Min. Mitth., 1872, 264) we learn that next to the anthophyllite-stratum and between it and the nucleus of biotite, is a stratum which has a seladon-green color, and appears to be a mixture of talc and chlorite, strongly altered. This observation is of very great interest in connection with the evident alteration of talc into anthophyllite, above described.

There is also an observation of Dr. F. Becke (Tschermak's Min. Mitth. [Neue Folge] iv, 450) who noticed the alteration of olivin into anthophyllite between the gabbro locality "Vier Linden" and the R. R. Station Rosswein in Saxony. The olivin shows in many places a commencing alteration into serpentine (*or talc?*), and is surrounded by a stratum of anthophyllite of from 5-6<sup>mm</sup> in thickness. This seems to be an analogous case, first, the olivin altered into serpentine (*or talc*), and this subsequently changed into anthophyllite.

#### IV. *Talc, pseudomorphous after Magnetite.*

In the vicinity of Dublin in Harford county, Md., is a series of rocks, consisting principally of gneiss and micaceous schists. They are underlaid by a bed of talcose slate, changing in some places into a very superior quality of massive soapstone, from 12 to 15 feet in thickness. Immediately adjoining, and under the talcose slates and soapstone, and in most cases separated from them by seams of chlorite or chlorite slate, lies a very large bed of a beautiful variety of green serpentine, mottled and of darker and paler green colors, of about 500 feet in thickness, and under this, a bed



of mottled black serpentine of about 800 feet, and frequently imbedded in the latter, masses of the same dark green serpentine. This immense bed of serpentine, in its two varieties, rests upon chloritic slates, with numerous crystals of magnetite in octahedra and twins, so called hemitropes, and talc slates, and below these again occurs another, but smaller bed of green serpentine of about 180 feet in thickness, which like the other is underlaid by chloritic and talcose slates, followed by a third bed of green serpentine.

A titaniferous variety of magnetite is found in lenticular masses of various sizes, intercalated between the green serpentine and is frequently bounded on the hanging wall by chloritic slates.

The green serpentine is quarried for ornamental purposes as it admits of a very fine polish and can be obtained in many beautiful shades of light and dark green.

The chloritic slate is generally of a very fine scaly structure, sometimes the scales become larger, from 0.5 to 1<sup>mm</sup> in diameter on an average, but rarely reaching 3<sup>mm</sup>.

At one locality in this large belt, a coarse scaly chlorite, immediately in contact with talc slate, has disseminated through it numerous small octahedra of talc, pseudomorphous after magnetite, an alteration, which, if I am correct, has never been observed before. These crystals from 1 to 2<sup>mm</sup> in diameter are of a silvery-white color and pearly lustre, the scales are arranged parallel to the octahedral planes, in the center is occasionally a small nucleus of magnetite, sometimes associated with pulverulent limonite.

This alteration of magnetite crystals into talc is of importance in connection with the steatite bed of 12 to 15 feet in thickness, to which I have above referred, because it shows that no good reason can be given to contradict the proposition that an entire magnetite bed has disappeared and has been replaced by steatite. This opinion is proved by the following observations.

The steatite is of a white or greenish-white color, it has mostly an uneven fracture, some seams in it, however, graduate into a slaty structure. Cryptocrystalline, and showing, when powdered, to be composed of an aggregate of exceedingly fine scales. *Disseminated through the whole mass are dark spots, from 0.1 to 10<sup>mm</sup> in diameter.* Especially the larger ones sometimes have a definite shape of squares or rhombs, or other forms, representing sections of magnetite crystals. These dark spots of a dark gray or iron-black color, are quite soft and can be reduced to a powder by the nail of a finger, and consist of fine scaly talc, colored by remnants of the original magnetite, which frequently can be separated by a magnet, or dissolved out by hydrochloric acid. That only a small number of the dark spots show the form of sections of magnetite, whilst most of them are without definite shape, shows that the original magnetite in the bed was granular or compact, but had, as is very common, crystals of magnetite disseminated through the whole mass.

V. *Gahnite*.

a. Already in 1876, at the Centennial Exhibition, I observed, amongst minerals from Western North Carolina, a specimen which was so unlike any species with which I was familiar, that I was in doubt about its nature. A little fragment of it which I afterwards received I put provisionally under gahnite. About a year ago I recognized the same mineral again amongst others which Mr. W. E. Hidden had collected in North Carolina, who very kindly gave me some fragments for investigation, which proved it to be gahnite.

Apparently without form, a fracture between splintery and conchoidal, and of a very rich, dark green color, which can best be observed by transmitted light.  $H = 7.5$ . Sp. Gr. = 4.576. The analysis is given below (a), after deducting 0.09%  $SiO_2$  and (a 2) the calculated results.

It occurs rarely at the Deake Mica Mine, Mitchell Co., N. C. The specimen at the Centennial Exhibition was about 4<sup>cm</sup> long and 3<sup>cm</sup> broad and, with an exception of thin micaceous coatings between fractures, was free from admixtures; Mr. Hidden's specimen was about 2 to 2.5<sup>cm</sup> in size, and was surrounded by a thin coating of about 1<sup>mm</sup> in thickness, consisting of yellowish-white fine scaly muscovite, evidently the result of alteration.

b. Last summer Mr. Charles E. Hall, of the Geological Survey of Pennsylvania, brought me for determination a number of specimens from the Cotopaxi Mine, Chaffee county, Colorado, which were found to be gahnite.

It occurs in large rough crystals, principally octahedra, some of the crystals show also the dodecahedral plane; the largest crystal which I have seen has an octahedral edge of 9<sup>cm</sup> in length; the crystals are often distorted and flattened out by the enlargement of two opposite octahedral planes. Besides containing inclosures of galenite, and, in smaller quantity of chalcopyrite and pyrite, they are very much altered.

When in a pure state it has a dark blackish-green color, and an uneven to subconchoidal fracture. The material for the analysis was very carefully selected, and first treated with sulphuric acid to remove the impurities, resulting from its alteration. Mr. Harry F. Keller has analyzed it in the Laboratory of the University of Pennsylvania, and obtained the results (b), after deducting 1.85 per cent. of silica; (b 1) are the results calculated from the analysis:

	a		b		a 1		b 1
$Al_2O_3$	= 54.86	—	60.76	—	$CuAl_2O_4$	= 0.69	—
$Fe_2O_3$	= 4.50	—	0.58	—	$ZnAl_2O_4$	= 86.34	— 53.94
$FeO$	= 1.14	—	4.56	—	$FeAl_2O_4$	= —	— 10.44
$MnO$	= 0.29	—	—	—	$MnAl_2O_4$	= 0.71	—
$CuO$	= 0.30	—	—	—	$MgAl_2O_4$	= 1.07	— 36.88
$ZnO$	= 38.05	—	23.77	—	$MgFe_2O_4$	= 2.46	—
$MgO$	= 0.79	—	10.33	—	$FeFe_2O_4$	= 3.67	— 0.84
					$Al_2O_3$	= 4.99	—
	<hr/>		<hr/>			<hr/>	<hr/>
	99.93		100.00		99.93		102.10

The analysis *a* shows an excess of nearly 5 per cent. of alumina, which is remarkable, as the separations in the analysis were most perfect. This gahnite does not come from a corundum locality, and it is therefore improbable that any has been inclosed in it.

In Mr. Keller's analysis, 2.10 per cent. of alumina are wanting to form spinel,  $RR_2O_4$ .

*c. Alterations of the Gahnite from Cotopaxi.*

Even the best and purest specimens from this locality, which appear to be quite fresh, show innumerable cracks, breaking them up into small angular fragments.

*a.* In most instances these are coated with a white earthy mineral, which dissolves in strong boiling hydrochloric acid. A qualitative analysis shows this coating to be a hydrous silicate of alumina and magnesia, and it is probably the same substance which in thicker coatings, has a finely fibrous structure, a white or greenish-white color and silky lustre. The thickest were not over 3<sup>mm</sup> in thickness, and were very much mixed with ferric oxide, and other impurities, some of them carbonates, as dilute hydrochloric acid liberates carbon dioxide. Does not exfoliate on ignition. The ignited mineral is readily decomposed by sulphuric acid.

The best material which I could obtain for analysis, although still very impure, was sufficiently pure to determine the position in the system where the mineral belongs. It was decomposed by sulphuric acid after ignition, then the silica extracted by sodium hydrate, and separated from this solution. About 6 per cent., insoluble in sulphuric acid and sodium hydrate, mostly gahnite, were deducted, and the following results obtained :

Ignition	=	13.82
SiO <sub>2</sub>	=	28.08
Al <sub>2</sub> O <sub>3</sub>	=	18.20
Fe <sub>2</sub> O <sub>3</sub>	=	4.32
CuO	=	0.82
PbO	=	1.80
ZnO	=	1.75
MgO	=	29.85
		98.64

Lead and zinc are probably present as carbonates, the ferric oxide as such, if I therefore deduct these as impurities, the following composition, which places this mineral near ripidolite, will probably not be far from the truth.

SiO <sub>2</sub>	=	31.68
Al <sub>2</sub> O <sub>3</sub>	=	20.54
MgO	=	33.68
H <sub>2</sub> O	=	14.10
		<hr/> 100.00

β. Another alteration, shown by many of the crystals, is that into a micaceous, chloritic mineral. It either forms a coating parallel with the octahedral planes or penetrates the crystals irregularly in every direction.

It has a white, grayish- or greenish-white color, is sectile and very little elastic. On ignition it does not exfoliate, but turns silver-white. The ignited mineral is easily decomposed by sulphuric acid. 0.2747 grms. although not quite, but nearly pure, was all that I could obtain for analysis, from which 0.0140 grms. insoluble in sulphuric acid and, subsequently, in sodium hydrate was deducted as impurity. The results were :

		Calculated :
SiO <sub>2</sub>	= 31.15	32.58
Al <sub>2</sub> O <sub>3</sub>	= 13.12	13.95
FeO	= 10.74	11.40
CuO	= 0.77	—
ZnO	= 0.39	—
MgO	= 29.23	29.86
Ignition	= 11.78	H <sub>2</sub> O = 12.21
Alkalies	?	—
	<hr/>	<hr/>
	97.18	100.00

These results show the mineral to belong to the chlorite group, closely agreeing with the formula  $H_{30} [Fe_{\frac{3.5}{2.0}} Mg_{\frac{1.65}{2.0}}]_{20} Al_6 Si_{12} O_{68}$ , for which I give calculated percentage above. It must remain undecided whether or not this is a new species, until larger quantities of pure material can be obtained for a fuller investigation.

#### VI. Rutile and Zircon from the Itacolomite of Edge Hill, Bucks County, Pa.

In the examination of a series of "Edge Hill rocks" which, according to Mr. Charles E. Hall (Report C6., of the 2d Geological Survey of Pennsylvania), are Potsdam sandstone, I have made a few observations which should be placed on record.

The rocks are generally thinly laminated quartzites which contain yellowish-white scales of muscovite in larger or smaller quantity, and are identical in appearance with the large mass of the "itacolomite" rocks of the Southern States, which do not show any flexibility.

Especially in Neeley's Quarry, but also in smaller quantity in many others, the rock contains exceedingly minute, yellowish, orange or brownish-yellow grains, they are smaller than 0.25<sup>mm</sup>. By powdering and levigation I have obtained a considerable quantity of the same.

Under the microscope they appear as irregular, sharp, angular fragments, showing now and then a very smooth plane, but no distinct crystalline form. They have a honey-yellow color. B. B. they gave the reaction of titanite oxide, and a very minute trace of tin.

Associated with the yellow grains are small crystals of a dark brown almost black tourmaline, small crystalline plates of menaccanite and colorless or slightly yellowish and brownish-white zircons, the latter more or less water-worn, but showing the planes of the prism *I*, the pyramid 1 and also less distinct, the planes of the pyramids *ii*, and 33.

As it is an impossibility to pick out enough of the pure yellow grains for analysis, I made several unsuccessful attempts to analyze the mixture, and obtained by Pisani's method 79.07% of titanio oxide.

I had, at the expense of one week's labor, picked out a little over two milligrams of *perfectly pure yellow grains*, which Dr. G. A. Koenig had the kindness to test by his colorimetric method, and pronounced to be *almost pure titanio oxide*, the yellow grains are therefore probably a variety of rutile.

In the rock itself the yellow grains show the same sharp angular forms above mentioned, whilst the zircons are water-worn. It appears from this that the rutile, tourmaline, mica and menaccanite crystallized or rather separated when or after the itacolumite was deposited, whilst the zircons, together with the quartz, are remnants of decomposed rocks, probably coming from granulites. In those of the South mountains, I have frequently observed microscopic zircons, very similar in form to those in the Edge Hill rocks. I may mention that Prof. Zirkel (Jahrb. f. Mineralogie, 1876, 90), has also detected microscopic zircons in the granulites of Saxony.

#### *Artificial Rutile and Octahedrite.*

Whilst decomposing some of the mixed yellow sands, containing about 80% of rutile, by fusion with a rather small quantity of potassium hydrogen sulphate, I was interrupted in my work for several hours, so that the greater portion of the potassium hydrogen sulphate was converted into potassium sulphate. By dissolving in cold water most of the titanio oxide went into solution, but I noticed a pale brownish, heavy, sandy substance, which, under the microscope, appeared in very brilliant crystals of the usual form of rutile *I* and *ii*, and pyramids 1 and 1*i*. One or two of the crystals were twins. There were, perhaps, several hundred of rutile crystals. Amongst these I observed *two* crystals of *octahedrite* which had the acute pyramid 1 and a decided *blue* color.

Experiments which I subsequently made for the purpose of making these artificial rutile crystals from pure titanio oxide were not very successful; although I have repeatedly obtained microscopic quadratic forms, I never could get any distinct brilliant crystals.

#### *VII. Sphalerite and Prehnite, from Cornwall, Lebanon Co., Pa.*

##### *a. Sphalerite.*

About two years ago small crystals of a greenish mineral were discovered by Mr. E. E. Craumer, of Lebanon, Pa., associated with a white crystalline coating upon the magnetite of the great Cornwall Ore Bank.

Lebanon county, Pa. I am indebted to him and also to Mr. J. Taylor Boyd, the General Superintendent of the Cornwall Ore Bank, for about a dozen of these *exceedingly rare crystals*, which I have found to be *sphalerite*. Only two or three distinct crystals were obtained, which were octahedra in hemitrope twins. Most of the crystals are very much distorted or imperfect for want of space for their development.

In color, they are between asparagus-green, brownish-green and light brown. Spec. grav. = 4.033.

The largest crystals are between 4 and 5<sup>mm</sup> in size. They occur in cavities of magnetite and are associated with a peculiar variety of prehnite, which sometimes envelops the sphalerite, magnetite, pyrite and crystallized chlorite, in small scales, frequently altered into a mineral resembling leidyite, which also envelops the magnetite crystals. There is too little of the latter for further examination.

The analyses of the sphalerite crystals gave the following results :

		1.	2.
S	=	32.69	33.06
Zn	=	66.47	} 66.96
Co	=	0.34	
Fe	=	0.38	
		<hr/> 99.88	<hr/> 100.02

#### b. Prehnite.

This occurs in crystalline incrustations upon magnetite, or as lining the cavities of the same. They consist of minute crystals and groups of crystals showing the planes *I*, *O*, and *ii*, forming frequently small globular, coxcomb and fan-shaped aggregations, colorless, white, yellowish and brownish-white. Sp. gr. = 3.042. The prehnite is the most recent formation, its incrustations covering magnetite, sphalerite, pyrite, chlorite and leidyite. The analysis of a carefully selected specimen gave :

SiO <sub>2</sub>	=	42.40
Al <sub>2</sub> O <sub>3</sub>	=	20.88
Fe <sub>2</sub> O <sub>3</sub>	=	5.54
CaO	=	27.02
H <sub>2</sub> O	=	4.01
Alkalies and MgO	=	traces
		<hr/> 99.85

#### VIII. Pyrophyllite in Anthracite.

At the meeting of the American Philosophical Society, of July 18th, 1879, I mentioned the very interesting occurrence of pyrophyllite in delicately fibrous incrustations from the Buck Mountain seam near Mahanoy City, Schuylkill county, Pa.

Identical in appearance and association it has lately been observed by

Mr. Oswald J. Heinrich, near Drifton, Luzerne county, in the Tomhicken Basin, which lies 75 feet above the Buck Mountain seam.

Another variety of pyrophyllite, which has the appearance of kaolinite, has also been found by Mr. Heinrich, near Drifton and Gowen, in the Buck Mountain seam. He has favored me with the following data, relative to its occurrence.

It is found principally in the upper bank of the seam which has a thickness of 5 to 6 feet and does not only occur in the planes of stratification and fissures, but even in the most compact anthracite. It has accumulated especially in layers or lenticular patches of from one-half to over one inch in thickness in the slate bank which divides the upper from the lower bank, and which has a thickness of from 8 to 15 inches, sometimes inclosing a few inches of anthracite. It is white or yellowish-white, compact, cryptocrystalline, slightly soils the fingers. Soft. Does not in the least exfoliate or expand on strong ignition. Sp. gr. = 2.812.

Not decomposed by sulphuric acid. The analysis of that from Cross Creek Colliery, near Drifton, Luzerne county, gave :

SiO <sub>2</sub>	=	65.77
Al <sub>2</sub> O <sub>3</sub>	=	29.36
Fe <sub>2</sub> O <sub>3</sub>	=	0.12
H <sub>2</sub> O	=	4.85
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		100.10

#### IX. *Beryl from Alexander Co., N. C.*

Many beautiful varieties of beryl have lately been found in Alexander county, N. C., and Mr. Wm. Earl Hidden especially has brought to light many of the most interesting specimens. To him I am indebted for a fragment of a rounded pebble which has a slightly leek-green color, turning brown by oxidation. It has a pretty distinct cleavage in one direction. Its specific gravity was found to be = 2.703. The analysis proved it to be beryl. It contained :

SiO <sub>2</sub>	=	66.28
Al <sub>2</sub> O <sub>3</sub>	=	18.60
Be <sub>2</sub> O <sub>3</sub>	=	13.61
FeO	=	0.22
Ignition,	=	0.83
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		99.54

#### X. *Allanite.*

Mr. W. E. Hidden found in the "Hiddenite" vein, Alexander county, N. C., associated with quartz, white orthoclase and little mica, small brownish-red, brownish-yellow or light brown crystals, which have the appearance of a partial decomposition or hydration, and a resinous lustre.



Their analysis proved them to be allanite. Sp. gr. = 3.005. As the quantity for examination was very small the cerium oxides were not separated.

For comparison I give the analysis of a variety of allanite from the Mica Mine of Balsam Gap in Buncombe Co., N. C., where it occurs in jet black or brownish-black slender crystals, sometimes from six to twelve inches in length (Minerals, &c. of North Carolina, Raleigh, 1881). Spec. grav. = 3.400.—

		Alexander Co.		Balsam Gap.
SiO <sub>2</sub>	=	32.05	—	32.79
Al <sub>2</sub> O <sub>3</sub>	=	22.93	—	18.16
Fe <sub>2</sub> O <sub>3</sub>	=	11.04	—	1.64
FeO	=	—	—	10.08
MnO	=	1.99	—	1.23
Ce <sub>2</sub> O <sub>3</sub>	}	=	—	6.07
(DiLa) <sub>2</sub> O <sub>3</sub>				
Y <sub>2</sub> O <sub>3</sub>	=	0.85	—	1.84
MgO	=	1.28	—	0.15
CaO	=	9.43	—	10.95
Na <sub>2</sub> O	=	0.54	—	0.33
K <sub>2</sub> O	=	0.20	—	0.12
Ignition	=	3.64	—	1.89
		—		—
		98.76		99.65

#### XI. *Nicolite from Colorado.*

In the American Journal of Science [3] xxiii, 380, Mr. Malvern W. Hles mentions the occurrence of smaltite near Gothic, Gunnison Co., Colorado, and gives an analysis of the same. He states that the Gem and other mines near Silver Cliff, Colorado, contain a number of nickeliferous minerals and a small amount of cobalt.

About two years ago I received fragments of niccolite from Colorado from some of my students, and about a year ago Mr. Henry A. Vezin sent me a specimen from Silver Cliff, which was pure enough for examination.

It occurs in rounded or nodular masses disseminated through a granular limestone, which has the appearance of dolomite, but contains only a very small percentage of magnesia. In dissolving the limestone, the niccolite remains in small irregular masses, partly made up by globular and botryoidal aggregations with a crystalline black surface, showing the crystals of niccolite to be exceedingly small and indistinct; I have not seen any in which the form could be made out. It has a very pale copper-red color with a grayish tint. Sp. gr. = 7.314.

Associated with it in druses of the limestone are globular crystalline groups of an apple-green mineral, which is probably an arseniate of nickel but which has not the appearance or annabergite.

The analysis of the niccolite gave :

As	=	46.81
Sb	=	2.24
S	=	2.52
Cu	=	1.59
Ni	=	44.76
Co	=	1.70
Fe	=	0.60
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		100.22

This is a niccolite in which a small portion of the arsenic is replaced by antimony and sulphur.

### XII. Artificial Alisonite (?).

About a year ago Mr. R. Pearce, Metallurgist of the Works of the Boston and Colorado Smelting Co., at Argo, Colorado, kindly sent me some very interesting crystals from furnace bottoms, which he had never before observed.

They were octahedral crystals, some showed cubical planes and slight indications of the dodecahedron; they were mostly distorted, cavernous, and many of them rounded, iron-black, and of metallic lustre. Spec. gr. = 5.545. Crystallized upon a plate of copper matte, containing a large percentage of metallic copper.

The analysis gave :

			Calculated.
S	=	15.23	— 17.61
Ag	=	2.16	— —
Cu	=	51.33	— 49.84
Pb	=	31.15	— 32.55
Fe	=	trace	— —
		<hr/>	<hr/>
		99.87	100.00

The composition is similar to alisonite or nearer  $2\text{PbS}$ ,  $5\text{Cu}_2\text{S}$  in which part of the copper is replaced by silver. The small percentage of sulphur can be accounted for from a small admixture of metallic copper, with which some of the crystals were contaminated.

UNIVERSITY OF PENNSYLVANIA, August 17, 1882.